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(54) **A novel thrombomodulin-like glycoprotein obtainable from urine.**

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Description

BACKGROUND OF THE INVENTION

The invention relates to a novel anticoagulant substance obtained from human urine, a process for its preparation and a pharmaceutical composition comprising the said substance for prevention and/or treatment of diseases related to the disorders in blood coagulation system.

As anticoagulant agents, heparin and antithrombin III are presently in use. Thrombolytic agents in use include urokinase, which is obtained from human urine or from cultured kidney cells, and streptokinase, which is extracted from beta-hemolytic streptococci. In addition, tissue plasminogen activator is now being developed.

On the other hand, it is well known that these drugs have side effects such as tendency of bleeding, and their anticoagulant or thrombolytic effect are not sufficient for the clinical use. In the field of fundamental investigation, an unknown substance was recently purified from rabbit lung extract and was identified as a novel physiological anticoagulant. The substance was named thrombomodulin [N. L. Esmon et al., J. Biol. Chem., Vol. 257, p.859 (1982)]. Thrombomodulin has two modes of action; an anticoagulant activity based on its anti-thrombin effect, and a fibrinolytic effect based on its stimulatory effect on thrombin-catalyzed protein C activation. Thrombomodulin is a receptor of thrombin on the endothelial cell surface, and, by binding thrombin, directly inhibits its procoagulant activity. Moreover, thrombin-thrombomodulin complex activates protein C which possesses a potent anticoagulant effect and a thrombolytic effect [I. Maruyama et al., J. Clin. Invest., Vol. 75, p.987 (1985)]. Since thrombomodulin exhibits not only an anticoagulant activity but also an enhancing effect on thrombolytic system, it is expected to be very useful for the treatment of blood coagulation disorders.

Since the thrombomodulin molecule mainly consists of peptides, thrombomodulin derived from a human, which has little antigenicity, ought to be administered to patients in order to avoid side effects such as anaphylactic shock. In regard to the isolation of human-derived thrombomodulins, there are some reports as described below. In the following explanation, molecular weights of the human-derived thrombomodulins, if not otherwise stated, are the results of measurements by sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE) under non-reduced condition.

P. W. Majerus et al. purified thrombomodulin from human placenta and reported its molecular weight as 75,000 [J. Biol Chem., Vol 259, p.12246 (1984)]. I. Maruyama et al. isolated thrombomodulin from human lung, which has activities similar to those of thrombomodulin from human placenta [J. Clin. Invest. , Vol. 75, p.987 (1985)]. N. Aoki et al. isolated thrombomodulin from human placenta and reported its molecular weight as 71,000 [Thrombosis Res., Vol. 37, p.353 (1985); and Japanese Patent Application Laid-Open Specification No. Sho 60-199819]. K. Suzuki et al. partially purified thrombomodulin from human platelets and determined its molecular weight as 78,000. They concluded in the report that all of the thrombomodulins obtained from human platelets, ones from human placenta and ones from human lung hemangio endothelial cells have similar activities by comparing their behaviors in SDS-PAGE, affinities to thrombin and substrate-affinities to protein C [J. Biochem., Vol. 104, p.628 (1988)].

There are also some reports about other substances which have activities similar to above-mentioned human thrombomodulins as described below.

P. W. Majerus et al. partially purified substances with molecular weights of 63,000 and 54,000 from human serum and also indicated that similar substances exist in human urine [J. Clin. Invest., Vol. 75, p.2178 (1985)]. H. Ishii et al. reported that substances with molecular weights of 105,000, 63,000, 60,000, 33,000, 31,000 and 28,000 (whether these were measured under reduced or non-reduced condition is not clearly described) are excreted in human urine [108th. Yakugakkai abstract 6F05, 11-1 (1988)].

Further, other substances with molecular weights of 200,000, 48,000 and 40,000 from urine [Japanese Patent Application Laid-Open Specification No. Sho 63-30423], and substances with molecular weights of 39,000 and 31,000 [Japanese Patent Application Laid-Open Specification Sho No. 63-146898] from urine are reported.

Meanwhile, by means of genetic engineering techniques, K. Suzuki et al. deduced the entire 557-amino acid sequence of human thrombomodulin from human lung cDNA clones [EMBO Journal, Vol 6. p.1891 (1987)]. They produced a series of peptides, which contain repeated Epidermal Growth Factor (EGF)-like structures in human thrombomodulin, by recombinant DNA techniques, and measured the effect of each peptide on thrombin-catalyzed protein C activation. Based on the obtained result, they concluded that all of the structure from the fourth through sixth EGF-like structures, which corresponds to 345th through 462nd amino acid residues numbered from amino-terminal of human thrombomodulin, is required for the exertion of thrombomodulin-like activity [J. Biol. Chem., Vol. 264, p.10351 (1989) and 12th. International Conference

on Thrombosis and Hemostasis program, p.334 (1989)].

The human thrombomodulins which have been already reported are obtained from human placenta, human lung or human platelets. They are not suitable for mass production because these materials could not be supplied in large quantities. Moreover, these thrombomodulins are difficult to handle, because some detergents are necessary in order to solubilize them. Contamination by detergents is unfavorable for clinical use of these thrombomodulins.

On the other hand, previously reported thrombomodulin-like substances have neither high activity of protein C activation nor efficient anticoagulant activity per unit protein. Accordingly, a novel thrombomodulin-like substance which is physiologically more active and more valuable in medical use is earnestly expected.

In the conventional processes for the purification of the thrombomodulin-like substances from human urine, some proteinase inhibitors such as aprotinin or bestatin are used to prevent the substances from decomposition. There are, however, other enzymes such as uropepsin which can not be completely inhibited by these proteinase inhibitors, and a complete prevention of the thrombomodulin-like substances from decomposition can not be easily achieved by these processes.

Further, since thrombomodulin is a glycoprotein, genetic engineering techniques could not provide a substance which possesses sugar chains completely equal to those of human thrombomodulin. Differences in sugar chains may cause unfavorable properties such as some side effects. For these reasons, it has been desired to obtain a thrombomodulin-like substance which resembles more closely to a native human thrombomodulin.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a novel anticoagulant substance with thrombin-binding properties derived from human urine.

Another object is to provide a process for preparation of the same.

The other object is to provide a pharmaceutical composition, which comprises the said anticoagulant substance as an active component, for prevention and/or treatment of diseases related to the disorders in blood coagulation system.

The substance of the present invention has a different molecular weight and different carboxy-terminal amino acid sequence from those of previously isolated thrombomodulin-like substances. The substance has renarkably high activity of thrombin catalyzed protein C activation and a potent anticoagulant effect, and gives superior in vivo effects.

BRIEF DESCRIPTION OF DRAWINGS

Figure 1 illustrates the effects of TM1 and human placental thrombomodulin on endotoxin induced disseminated intravascular coagulation (DIC) model in rats.

Figure 2 illustrates the effects of TM1, TM2 and human placental thrombomodulin on thromboplastin induced DIC in rats.

Figure 3 illustrates SDS-PAGE of TM1, TM2 and human placental thrombomodulin under non-reduced conditions.

DETAILED DESCRIPTION OF THE INVENTION

As a result of extensive investigations concerning development of anticoagulant substances in human urine, the present inventors have found a novel thrombomodulin-like substance, which has a different molecular weight as compared to previously isolated thrombomodulin-like substances, a remarkably high activity of thrombin-catalyzed protein C activation, a potent anticoagulant effect and superior physiological effects, and have finally accomplished the present invention.

According to the present invention, the anticoagulant substances of the present invention may be prepared by purification from fresh or concentrated human urine by suitably combining ion-exchange chromatography, affinity chromatography using thrombin-bound resin, gel filtration chromatography, adsorption chromatography, hydrophobic chromatography and/or polyacrylamide gel electrophoresis after alkalization and heat-treatment.

The process for preparation of substance of the present invention is practiced, for example, in the following manner. Human urine is firstly adjusted to a pH of 8 to 9, preferably to 8.3 ± 0.3, for the purpose of inactivation of contaminating proteinases. After removal of the precipitate and neutralization of pH, the

resultant solution is concentrated, for example, using an ultrafiltration membrane with a cut-off molecular weight of 10,000 to 40,000. After the pH of the concentrate is adjusted to 5 to 10, preferably to 7.3 ± 0.2, the concentrate is heat-treated at a temperature of 50 to 70 °C for 5 to 45 min., preferably at 60 ± 5 °C for 15 ± 5 min., in order to inactivate residual proteinases. The concentrate is then subjected to anion-exchange chromatography which had been equilibrated at pH 5.5 to 7.5, more preferably at pH 6.5 ± 0.2 to adsorb active components. The active components are then eluted with a buffer at pH of 2 to 4.5, preferably at pH 4.0 ± 0.05. The eluate containing the active components is desalted and concentrated, for example, using an ultrafiltration membrane with a cutoff molecular weight of 10,000 to 40,000 and is adsorbed to an affinity column, where thrombin is used as a ligand. The column is then washed with a buffer containing 0.05 to 0.8 M, preferably 0.1 to 0.7 M, of NaCl, and is eluted with a buffer containing 0.9 to 2.0 M, more preferably 1.0 ± 0.05 M, of NaCl. The collected fractions are concentrated and, if necessary, the thrombin affinity chromatography is repeated. If it is necessary, the eluted active fraction is passed through a gel-filtration column repeatedly, and active fractions corresponding to the substance of the present invention (TM1 or TM2, which will be described hereafter) are collected. Alternatively, the above-mentioned concentrated eluate from thrombin affinity chromatography can be subjected to SDS-PAGE to obtain the substance of present invention. The substance may be heat-treated at 60 °C ± 2 °C for 10 hrs. in order to inactivate contaminating viruses to be in a more suitable form as a pharmaceutical composition.

Diethyl amino ethyl-(DEAE-) Cellulose, DEAE-Sepharose®, DEAE-Cellulofine, DEAE-Toyopearl or the like can be used as anion-exchange resins in above-mentioned purification process. A thrombin affinity column can be obtained by binding thrombin to resins such as cellulose, agarose or dextran by using cyanogen bromide, followed by a treatment with diisopropylfluorophosphate, phenylmethansulfonyl fluoride or the like. As resins for gel filtration, Sephacryl® S-200, Sephacryl® S-300, Sephadex® G-100, G-150, G-200, Toyopearl HW-55, Biogel® P-100, P-150, Sepharose® 6B or the like can be used.

According to above-mentioned procedure, the anticoagulant substance of the present invention can be obtained as a purified form.

The anticoagulant substance of the present invention and related substances are characterized by following properties;

(a) Molecular weight:

72,000 ± 3,000

Method of the determination:

Molecular weight was determined by SDS-PAGE according to the method of Laemmli [Nature vol 227, p.680, (1970)] using 7.5% polyacrylamide gel. under non-reduced condition. "Molecular weight standard kit" (product of Seikagaku Kogyo Co., Japan) and phosphorylase A (product of Boeringer Mannheim Yamanouchi, West Germany) were used as standard proteins. Electrophoresis was carried out at a constant current of 7 mA for 20 hrs.

(b) Amino acid composition (mol %):

Aspartic acid	9.5 ± 2.0	Methionine	1.1 ± 0.5
Threonine	4.0 ± 1.5	Isoleucine	2.8 ± 1.5
Serine	5.1 ± 1.5	Leucine	7.5 ± 2.0
Glutamic acid	10.9 ± 2.5	Tyrosine	1.6 ± 1.5
Proline	9.3 ± 1.5	Phenylalanine	3.7 ± 1.5
Glycine	11.0 ± 3.0	Histidine	2.5 ± 1.0
Alanine	11.7 ± 3.0	Lysine	0.8 ± 0.5
Cysteine	8.0 ± 4.0	Arginine	4.6 ± 1.5
Valine	5.9 ± 1.5		

Method of the determination:

After 1 mg of the substance of present invention was completely acid-hydrolyzed according to the method of Moore et al. [Methods in enzymol., vol.6, p.819, (1963)], amino acid composition was analyzed by amino acid analyzer (product of Beckman Co., West Germany).

(c) Terminal amino acid sequence

Amino terminal:

Ala-Pro-Ala-Glu-Pro-Gln-Pro-Gly-
Gly-Ser-Gln-Cys-Val-Glu-His-Asp-
Cys-Phe-Ala-Leu-Tyr-Pro-Gly-Pro
Ala-Thr-Phe-Leu-

Carboxy terminal: -Leu-Ala-Arg
(Wherein Ala represents an alanine residue, Pro a proline residue, Glu a glutamic acid residue, Gln a glutamine residue, Gly a glycine residue, Ser a serine residue, Cys a cysteine residue, Val a valine residue, His a histidine residue, Asp an aspartic acid residue, Phe a phenylalanine residue, Leu a leucine residue, Tyr a tyrosine residue, Thr a threonine residue and Arg an arginine residue.)

Method of the determination:

Twenty-five mg of the substance of the present invention was reduced and carboxymethylated according to the method of C.H. Hirs [Methods in Enzymol., vol.11, p.199, (1967)] and subjected to terminal amino acid sequence analysis. Amino terminal sequence was determined using a gas phase amino acid sequencer (product of Applied Biosystems Co., Type 470A, USA). Carboxy terminal sequence was determined by digestion with carboxypeptidase P (product of Peptide Institute Inc., Japan) according to the method of S. Yokoyama [Biochem. Biophys. Acta., vol. 397, p.443, (1975)], followed by amino acids analysis using an amino acids analysis system (product of Nihonbunko Co., Japan).

As shown in the result, the amino terminal amino acid sequence of the substance of the present invention is completely consistent with the results already reported. However, the carboxy terminal amino acid sequence of the substance of the present invention, -Leu-Ala-Arg, is in good agreement with the amino acid sequence in 454th through 456th position of the molecule in Suzuki's report. Namely, the carboxyl terminal of the substance of the present invention is in the position 6 amino acid residues shorter than the carboxy terminal of a peptide having amino acid sequence in 345th through 462th position of the molecule in Suzuki's report, which they insist to be a minimal active unit for the cofactor activity on thrombin-catalyzed protein C activation. This indicates that the complete amino acid sequence of the minimal active unit in Suzuki's report is not necessary for exertion of the activity. The substance provided by the present invention includes an isomer, in which the second amino acid from the carboxy terminal indicated above, alanine, is replaced with valine, because similar substitution in corresponding position of human thrombomodulin is already well known.

(d) Sugar composition (W/W %):

Neutral sugar:	5.5±1.0
Amino sugar:	2.2±1.0
Sialic acid:	2.8±1.5

Method of the determination:

Neutral sugar was determined by Phenol-sulphuric acid method [Nature vol.168, p.107, (1951)]. Amino sugar was determined according to the method of Elson-Morgan (Blix's modification) [Acta. Chem. Scand., vol.2, p.467, (1948)] after the substance of present invention was heat-treated at 100 °C for 4 hrs in 4 N HCl solution. Sialic acid was determined by the method of Warren [J. Biol. Chem., vol.234, p.1971, (1959)] after the substance of present invention was heat-treated at 80 °C for an hour in 0.1 N HCl solution.

(e) Absorbance at 280 nm ($E^{1\%}_{1cm}$) :

7.7 ± 1.0

Method of the determination:

Ten mg of freeze-dried substance of the present invention was dissolved in 1 mL of distilled water and suitably diluted. Absorbance at 280 nm was measured by spectrophotometer (Hitachi Co. type 3200, Japan) and

$$E^{1\%}_{1cm}$$

(280nm) was calculated.

(f) Isoelectric point:

3.9 ± 0.2

Method of the determination:

Isoelectric point was measured by isoelectric electrophoresis using Ampholite (product of LKB Co., pH 2.5 to 4.5, Sweden). Electrophoresis was carried out at a voltage of 500 V for 40 hrs.

(g) Stability

The results of stability tests were summarized in Table 1;

Table 1

Conditions	Residual activity(%)
1. 1% mercaptoethanol(V/V)	0
2. 1% SDS(W/V)	80
3. 8 M urea	93
4. 6 M guanidine-HCl	100
5. pH 2.0	100
6. pH 10.0	91
7. 60 °C for 300 min	95

As for conditions No.1 through 6, 60 µg/mL of the substance of the present invention was treated under indicated conditions at a temperature of 25 °C for 150 min. As for condition No.7, 60 µg/mL of the substance of the present invention was treated at pH of 7.5. Resultant samples were diluted 100 fold and subjected to measurement of thrombin catalyzed protein C activating cofactor activity. Assay method of protein C activation was described thereafter. Residual activity was expressed as percentages compared with non-treated sample. The substance of the present invention is stable in 1% SDS, 8 M urea or 6 M guanidine-HCl but is readily inactivated by reduction with mercaptoethanol. It is stable even in low or high

(2 or 10) pH conditions and is also stable after heating at 60 °C for 300 min.

(h) Solubility

The substance of the present invention can be dissolved in distilled water at a concentration of 30 mg protein/ml or more at room temperature.

As described above, the substance of the present invention is a novel substance which has a molecular weight different from those of previously reported thrombomodulins. The substance is more advantageous than thrombomodulins extracted from placenta or lung, because detergents are not necessary for its solubilization.

The substance of the present invention has following effects.

(1) Affinity to thrombin (anti-thrombin activity)

(a) The substance of the present invention was adsorbed almost 100% by DIP-thrombin-agarose gel-chromatography.

(b) One hundred μL of a solution containing TM1 and and 100 μL of bovine thrombin (1 U/mL, product of Mochida Pharmaceutical Co., Japan) were mixed and incubated at 37 °C for 30 min. One hundred μL of Human fibrinogen solution (2 mg/mL) was then added to the mixture to measure clotting time using coagulometer (product of Amerung Co., West Germany). Results are shown in Table 2.

Table 2

Drugs	Conc.(OD280)	Clotting time(sec)
Control	-	41.2
Substance of the invention	0.01	>900

As shown in Table 2, the substance of the present invention possesses an ability to bind thrombin and inhibit its coagulant activity.

The results shown in Table 2 indicate that the anti-thrombin activities of the substances are more than 50 to 60 times as potent as that of human thrombomodulin which was previously reported. This can be assured, for example, by following comparison. The effect of thrombomodulin purified from human placenta on clotting time, which was cited in Japanese Patent Application Laid-Open Specification No. Sho 62-169728, is shown as a reference in Table 3. According to the specification, the human placental thrombomodulin was proved to be more than twice as potent as previously reported human thrombomodulins. It can be concluded that the anticoagulant activity of the substance of the present invention is more potent than that of previously reported thrombomodulins by comparing Table 2 with Table 3.

Table 3

Drugs	Conc.(OD280)	Clotting time(sec)
Control	-	35.8
human placental thrombomodulin	0.42	62.3
	0.84	109.9

The anticoagulant effect of human urine-derived thrombomodulin, which was cited in Japanese Patent Application Laid-open Specification No. Sho 63-30423, is shown as a reference in Table 4. By comparing Table 2 with Table 4, it becomes also clear that the substance of the present invention possesses anticoagulant activity much potent than previously reported human thrombomodulins.

Table 4

Drug	Conc.(OD280)	clotting time(sec)
Control	-	53.4
human urinary thrombomodulin	0.1	>500

(2) Stimulatory effect on thrombin-catalyzed activation of protein C

Stimulatory effect of TM1 and TM2 on thrombin-catalyzed activation of protein C was examined using rabbit thrombomodulin (product of American Diagnostica Inc., USA) as a standard. Namely, 20 μL of bovine thrombin solution (10 U/mL, product of Mochida pharmaceutical Co., Japan) mixed with 60 μL of 0.1 M Tris HCl buffer (pH 7.5) and 10 μL of various concentration (0 to 15 μg/mL) of either rabbit thrombomodulin, TM1 or TM2. Ten μL of human protein C (product of American diagnostica Inc., USA) solution (500 μg/mL) was added to the mixture. After 30 min of reaction at 37 °C, reaction was stopped by an addition of 150 μL of equivolume mixture of 1 U/mL human antithrombin III (product of Green Cross Co., Japan) solution and 10 U/mL heparin (product of Mochida Pharmaceutical Co. Japan) after 15 min of incubation at 37 °C, 250 μL of of a synthetic substrate (Tert-butoxycarbony-Leu-Ser-Thr-Arg-MCA, product of peptide Institute Inc., Japan) solution (0.1 mM) was added to the reaction mixture, and then incubated at 37 °C for 10 min. Five hundred μL of 20% acetic acid solution was added to the mixture for the termination of the reaction, followed by a measurement of fluorescence of the released 7-amino-4-methyl-coumarin (AMC) using a fluorospectrophotometer at an excitation wave length of 380 nm and emission at 460 nm. The amount of TM1 or TM2 which is equivalent to 1 mg of rabbit thrombomodulin in activating thrombin-catalyzed protein C was calculated using a calibration curve obtained as described above, and was expressed as 1 mg equivalent to rabbit thrombomodulin (mg eq.).

As a result, the specific activity of the substance of the present invention is 2.3 mg eq./mg protein [protein was determined according to the method of Lowry et al. J. Biol. Chem., Vol.156, p.564 (1945)]. This result indicates that the substance of the present invention possesses evident abilities of protein C activation in combination with thrombin, and that the abilities of the substances of the present invention are more potent than that of previously reported thrombomodulins.

(3) Anticoagulant activity

One hundred μL of citrated human platelet poor plasma (PPP) and 10 μL of the substance of the present invention in various concentrations (10 to 1000 μg eq./mL) was mixed and incubated at 37 °C for 2 min. One hundred μL of thrombin (2 U/mL, Green Cross Co., Japan) was added to the mixture for the measurement of clotting time. Average of three experiments is shown in Table 5.

Table 5

Drugs	Amount(μg eq.)	Clotting time (sec)
Control	-	22.7
Substance of the invention	0.1	23.8
	1	31.2
	10	188.8

As shown in the results, the substance of the present invention prolongs the clotting time significantly.

In vivo anticoagulant effect of the substance of the present invention is explained using experimental examples provided hereafter.

Experimental example 1 :

Effect on endotoxin-induced disseminated intravascular coagulation (DIC) model in rats

The experiment was performed according to the method of T. Yoshikawa et al. [Nippon Ketsuekigakkai Zasshi, vol.45 (3), p.633-640, (1982)]. Female Wistar rats weighing 160-200 g were anesthetized with pentobarbital, and lipopolysaccharide (product of Difco Laboratories, USA) was infused at a dose of 25 mg/kg in 4 hrs to establish DIC model. Either the substance of the present invention or human placental thrombomodulin dissolved in 0.01 M phosphate buffer (pH 7.0) containing 0.1% human serum albumin and 0.14 M NaCl was infused simultaneously for 4 hrs. at a dose of 1.2 mg protein/kg. Lubrol (0.005%) was added to the solution in case of human placental thrombomodulin for the purpose of solublization. Blood samples were taken before and after the drug infusion and platelet count and plasma fibrinogen level were measured. In control group, only the vehicle was infused instead of drug solution. The result is expressed as percent inhibition as compared to the control as shown in Fig. 1. Inhibition was calculated as follows.

Inhibition(%): [(Decrease in the control group) -(Decrease in the administered group)] / (Decrease in the control group) × 100.

Decreased platelet count and plasma fibrinogen level in rat endotoxin DIC model were significantly restored by the injection of the substance of the present invention.

Experimental example 2 :

Effect on thromboplastin-induced DIC model in rats

The experiment was performed according to the method of H. Ohno et al. [Thrombosis Res., vol.24, p.445, (1981)]. Male Wistar rats weighing 240-270 g were anesthetized with ethyl carbamate and thromboplastin (Simplastin®, product of Organon Teknika Corp., USA) was infused at a dose of 25 mg/kg in 20 min to establish DIC model. Either the substance of the present invention or human placental thrombomodulin dissolved in 0.01 M phosphate buffer (pH 7.0) containing 0.1% human serum albumin, 0.14 M NaCl and 0.01% Lubrol was infused at a dose of 0.25 mg protein/kg for 90 min starting 30 min before the beginning of the thromboplastin injection. Blood samples were taken before and after the drug infusion and platelet count and plasma fibrinogen level were measured. In the control group, only the vehicle was infused instead of drug solution. The result is expressed as percent inhibition as compared to the control as shown in Fig. 2. Inhibition was calculated in the same manner as in Experimental example 1.

Decreased platelet count and plasma fibrinogen level in this DIC model were also significantly restored by the injection of the substance of the present invention

The in vivo effect of the substance of the present invention as well as in vitro effect, was proved to be more potent than that of previously reported thrombomodulins. In another aspect, since the thrombomodulin-like substance synthesized by Suzuki et al utilizing genetic engineering techniques possesses anticoagulant activity equal to the existing thrombomodulins purified from human tissues [EMBO J. vol.6, p.1891, (1987) and Japanese Patent Application Laid-Open Specification No. Hei 1-6219, (1989)], it is clear that the effects of the substance of the present invention is more potent than that of recombinant thrombomodulin-like substances.

Experimental example 3 :

Acute toxicity test in mice

Acute toxicities of the substance of the present invention was examined. Ten male ddY mice were intravenously injected the substance of the present invention at a dose of 200 mg eq./kg. Neither serious side effects nor death was observed in 7 days after the drug administration.

As described above, the substance of the present invention possesses a potent anticoagulant effect in vivo as well as in vitro, and the potency of these effects were higher than those of existing thrombomodulins. The safety of the substance of the present invention was also demonstrated.

The substance of the present invention may be used, for example, for the treatment and prevention of diseases related to disorders in blood coagulation systems, such as DIC, various types of thrombosis, obstruction of peripheral blood vessels, myocardial infarction, brain infarction, transient ischemic attack,

gestosis and liver or kidney insufficiency.

The present substance may be employed as pharmaceutical compositions such as injections, inhalants and suppositories, preferably injections, containing the present substances with appropriate, pharmaceutically acceptable carriers or medium such as sterilized water, physiological saline, edible oils, non-toxic organic solvents or non-toxic solubilizer such as glycerin or propylene glycol. The composition may be mixed with auxiliary agents which is conventional in pharmaceutical art such as, excipients, binders, coloring agents, corrigents, emulsifying agents, suspending agents, stabilizing agents or preservatives.

When the compositions are injections, they may be administered once or divided 2 to 6 times or by instillation, etc. While dose varies depending upon age, body weight and condition of the patient, conditions and kinds of diseases, etc., from 0.05 to 500 mg eq., preferably from 0.1 to 10 mg eq., can be used as a daily dose for an adult.

In addition, the substance of the present invention may be used for the prevention of blood coagulation by being bound to the surface of medical implements such as artificial blood vessels, artificial organs or catheters using bridging agents or the like.

Examples:

The process for the preparation of the substance of the present invention will be described in more detail with reference to the following Examples, which are not intended to be limiting the scope of the present invention unless otherwise specified.

Example 1:

One hundred L of fresh human urine obtained from healthy males with the use of preservatives, for example phenol, was adjusted to pH 8.5 using 10% NaOH solution, and the precipitate was removed. After being adjusted to pH 5.5 using 4 M HCl, the urine was filtrated by acrylonitril fibers for the purpose of adsorption of urokinase, and concentrated using an ultrafiltration membrane filter with a cutoff molecular weight of 40,000. The concentrate is adjusted to pH 7.3, and heat-treated at a temperature of 60 °C for 15 min. The concentrate was then subjected to DEAE-cellulose (product of Whatman Co., USA) column (300 mL) which had been equilibrated with a 0.05 M phosphate buffer (pH 6.5) containing 0.068 M NaCl to adsorb an active component, followed by washing with 750 mL of the same buffer as used in the equilibration and then eluted with an acetate buffer (pH 4.0) containing 0.05 M NaCl. After desaltation and concentration of the active eluent by ultrafiltration membrane with a cutoff molecular weight of 30,000, the pH of the concentrate was adjusted to 7.5 using 2 M NaOH. The concentrate was then passed through a DIP-thrombin-agarose column (2.5 mL) which had been equilibrated with a 0.02 M Tris HCl buffer (pH 7.5) containing 0.1 M NaCl, 1 mM benzamidine HCl and 0.5 mM $CaCl_2$ to adsorb active components. The column was washed with 25 mL of the same buffer as used in the equilibration, and was eluted with a 0.02 M tris HCl buffer (pH 7.5) containing 1.0 M of NaCl, 1 mM benzamidine HCl and 0.5 mM EDTA. The active fraction is then dialysed against the same buffer as used in the equilibration and adsorbed again to the DIP-thrombin-agarose column which had been equilibrated in the same condition as described above. The column was washed with 10 mL of the same buffer as used in the equilibration, and washed again with 10 mL of 0.02 mM Tris HCl buffer (pH 7.5) containing 0.8 M NaCl, 1 mM benzamidine HCl and 0.5 mM $CaCl_2$. The active fraction was then eluted with 0.02 mM Tris HCl buffer (pH 7.5) containing 1.0 M of NaCl, 1 mM benzamidine HCl and 0.5 mM EDTA. After being concentrated using an ultrafiltration membrane with a cutoff molecular weight of 30,000, the eluted active fraction was passed through a Sephacryl® S-300 (product of Pharmacia Fine Chemical Co.) column (500 mL) which had been equilibrated with 0.01 M phosphate buffer (pH 7.0) containing 0.14 M NaCl and then the active fraction was collected. The fraction was again subjected to the Sephacryl® S-300 column in the same conditions as before, to obtain the substance of the present invention. The amount of purified TM1 and TM2 were 247 and 166 μg eq., respectively. SDS-PAGE patterns of the purified substances and human placental thrombomodulin described in Reference Example were shown in Fig. 3. The molecular weights of TM1 or TM2 are distinctly different from that of human placental thrombomodulin. Each of the substances was demonstrated as a single band on the SDS-PAGE.

Typical examples of formulations of the present invention will be shown below.

Example 2: freeze-dried parenteral injection

Substance of the present invention	20 mg eq.
Purified gelatin	50 mg
Sodium phosphate	34.8 mg
Sodium chloride	81.8 mg
Mannitol	25 mg

The above components were dissolved in 10mL of distilled water for injection. The obtained solution was sterilized by filtration, and 1.0 mL each of this solution was put into sterilized vials, freeze-dried and sealed by ordinary methods, to produce a freeze-dried preparation for parenteral injections.

Reference example:

An example of the preparation of human placental thrombomodulin

Human placental thrombomodulin was purified according to the method of N. Aoki et al [Japanese Patent Application Laid-Open Specification No. Sho 60-199819]. Shortly, thirty human placentae (about 12 kg) were washed with 0.02 M tris-HCl buffer (pH 7.5) containing 0.25 M sucrose and 1 mM benzamidine HCl and ground into a homogenous liquid mixture. The homogenized mixture was centrifuged at 3,000 rpm for 40 min to collect a precipitate. The precipitate was suspended in the buffer mentioned above, stirred for 10 min and again centrifuged to collect a precipitate. The above procedure was repeated for three times using 20 L of the buffer each time and the precipitates obtained were combined together and extracted with 60 L of 0.02 M tris-HCl buffer (pH 7.5) containing 0.25 M sucrose, 1 mM benzamidine HCl and 0.5%(V/V) Triton® X-100 (product of Sigma) to obtain a crude extract. The protein content of the crude extract was 46.7 g (Protein was determined according to the method of Lowry et al. The method hereafter was the same unless otherwise specified.). The crude extract (60 L) was applied to a DIP-thrombin-agarose column ($4\phi \times 16$cm) which had been equiliberated with 0.02M Tris HCl buffer (pH 7.5) containing 0.1M NaCl, 0.5mM $CaCl_2$, 0.1 mM benzamidine HCl and 0.5%(V/V) Triton® X-100. The column was then washed with 2 L of the same buffer as used in the equilibration. The column was then eluted using a 0.02 M tris-HCl buffer (pH 7.5) containing 1 mM NaCl, 0.1 mM EDTA, 1 mM benzamidine HCl and 0.5%(V/V) Triton® X-100 and active fractions were collected. The volume of the eluate was 650 mL and the total protein content of the eluate was 1.7 g. The eluate was then concentrated using an ultrafiltration apparatus (Milipore Ltd.) with a cutoff molecular weight of 30,000 and applied to the DIP-thrombin-agarose column which had been treated in the same manner described above. Thereafter, the column was washed with 150 mL of a 0.02 M tris-HCl buffer (pH 7.5) containing 0.4 M NaCl, 0.5 mM $CaCl_2$, 0.1 mM benzamidine HCl and 0.5%(V/V) Triton® X-100 and eluted by a gradient elution technique using a solution obtained by adding NaCl (0.4 to 1 M) to a 0.02 M tris-HCl buffer (pH 7.5) containing 0.1 mM EDTA, 1 mM benzamidine HCl and 0.5%(V/V) Triton® X-100. The eluate was collected in 30 mL-fractions. The net volume of the active fractions was 1,290 ml and the protein content 68 mg. The collected fraction was concentrated using ultrafiltration apparatus (Milipore Ltd.) with a cutoff molecular weight of 30,000 and passed through a S-300 (product of Farmacia Co.) column ($2.6\phi \times 90$cm) which had been equilibrated with 0.01M phosphate buffer (pH 7.0) containing 0.05% Triton® X-100 and 0.14M NaCl, and the active component was collected. The obtained human placental thrombomodulin was 3.1 mg.

Claims

Claims for the following Contracting States : AT, BE, CH, DE, FR, GB, IT, LI, LU, NL, SE

1. A purified glycoprotein with anticoagulant activity obtainable from human urine, which is characterized by the following properties:
   (a) affinity:
   it has a high affinity to thrombin;
   (b) activity:
   it stimulates thrombin-catalyzed protein C activation;
   (c) amino acid composition (mol %):

Aspartic acid	9.5 ± 2.0
Threonine	4.0 ± 1.5
Serine	5.1 ± 1.5
Glutamic acid	10.9 ± 2.5
Proline	9.3 ± 1.5
Glycine	11.0 ± 3.0
Alanine	11.7 ± 3.0
Cysteine	8.0 ± 4.0
Valine	5.9 ± 1.5
Methionine	1.1 ± 0.5
Isoleucine	2.8 ± 1.5
Leucine	7.5 ± 2.0
Tyrosine	1.6 ± 1.5
Phenylalanine	3.7 ± 1.5
Histidine	2.5 ± 1.0
Lysine	0.8 ± 0.5
Arginine	4.6 ± 1.5;

(d) terminal amino acid sequence:
amino terminal:

Ala-Pro-Ala-Glu-Pro-Gln-Pro-Gly-Gly-Ser-Gln-
Cys-Val-Glu-His-Asp-Cys-Phe-Ala-Leu-Tyr-Pro-
Gly-Pro-Ala-Thr-Phe-Leu-

carboxyl terminal:
-Leu-Ala-Arg;

(e) stability:
(1) stable at pH 2 to 10,
(2) stable at 60 °C for 300 min.,
(3) stable in 1 % (W/V) SDS,
(4) stable in 6 M guanidine hydrochloride,
(5) stable in 8 M urea ;

(f) molecular weight:
72,000 ± 3,000;

(g) sugar composition (% W/W):

(1) neutral sugar:	5.5 ± 1.0,
(2) amino sugar:	2.2 ± 1.0,
(3) sialic acid:	2.8 ± 1.5;

(h) absorbance at 280 nm

$(E^{1\%}_{1cm})$:

7.7 ± 1.0 (in aqueous solution);

(i) isoelectric point:
pH 3.9 ± 0.2 .

2. A process for preparing a glycoprotein with anticoagulant activity obtainable from human urine as defined in claim 1
comprising the steps of
(1) adjusting pH of human urine at first to 8.3 ± 0.3, and then removing of the precipitates,
(2) subsequently adjusting pH of the urine to 7.3 ± 0.2,
(3) then heating the urine at 60 ± 5 °C for 15 ± 5 min.,
(4) then fractionating the treated urine by affinity chromatography using thrombin-binding resin, ion exchange chromatography, gel filtration alone or in combination thereof to collect the active components.

3. A pharmaceutical composition for prevention or treatment of diseases related to disorders in blood coagulation systems, which comprises a pharmaceutically acceptable carrier and a glycoprotein with anticoagulant activity obtainable from human urine as defined in claim 1.

Claims for the following Contracting States : ES, GR

1. A process for preparing a glycoprotein with anticoagulant activity obtained from human urine having the following properties:
(a) affinity:
it has a high affinity to thrombin;
(b) activity:
it stimulates thrombin-catalyzed protein C activation;
(c) amino acid composition (mol %):

Aspartic acid	9.5 ± 2.0
Threonine	4.0 ± 1.5
Serine	5.1 ± 1.5
Glutamic acid	10.9 ± 2.5
Proline	9.3 ± 1.5
Glycine	11.0 ± 3.0
Alanine	11.7 ± 3.0
Cysteine	8.0 ± 4.0
Valine	5.9 ± 1.5
Methionine	1.1 ± 0.5
Isoleucine	2.8 ± 1.5
Leucine	7.5 ± 2.0
Tyrosine	1.6 ± 1.5
Phenylalanine	3.7 ± 1.5

(d) terminal amino acid sequence:
amino terminal:

Ala-Pro-Ala-Glu-Pro-Gln-Pro-Gly-Gly-Ser-Gln-
Cys-Val-Glu-His-Asp-Cys-Phe-Ala-Leu-Tyr-Pro-
Gly-Pro-Ala-Thr-Phe-Leu-

carboxyl terminal:
-Leu-Ala-Arg;
(e) stability:
(1) stable at pH 2 to 10,
(2) stable at 60 °C for 300 min.,
(3) stable in 1 % (W/V) SDS,
(4) stable in 6 M guanidine hydrochloride,

(5) stable in 8 M urea,

(f) molecular weight:

72,000 ± 3,000;

(g) sugar composition (% W/W):

(1) neutral sugar:	5.5 ± 1.0,
(2) amino sugar:	2.2 ± 1.0,
(3) sialic acid:	2.8 ± 1.5;

(h) absorbance at 280 nm

$$(E^{1\%}_{1cm}):$$

7.7 ± 1.0 (in aqueous solution);

(i) isoelectric point:

pH 3.9 ± 0.2 .

comprising the steps of

(1) adjusting pH of human urine at first to 8.3 ± 0.3, and then removing of the precipitates,

(2) subsequently adjusting pH of the urine to 7.3 ± 0.2,

(3) then heating the urine at 60 ± 5 °C for 15 ± 5 min.,

(4) then fractionating the treated urine by affinity chromatography using thrombin-binding resin, ion exchange chromatography, gel filtration alone or in combination thereof to collect the active components.

2. Use of the glycoprotein as obtainable from the process according to claim 1 for the preparation of a pharmaceutical composition or the prevention and/ or treatment of diseases related to the disorder in blood coagulation systems.

Patentansprüche

Patentansprüche für folgende Vertragsstaaten : AT, BE, CH, DE, FR, GB, IT, LI, LU, NL, SE

1. Gereinigtes Glycoprotein mit Antikoagulanzaktivität, erhältlich aus humanem Urin, welches durch folgenden Eigenschaften charakterisiert ist:

(a) Affinität:

Es hat eine hohe Affinität zu Thrombin;

(b) Aktivität:

Es stimuliert die Thrombin-katalysierte Protein-C-Aktivierung;

(c) Aminsäurezusammensetzung (mol%):

Asparaginsäure	9,5 ± 2,0
Threonin	4,0 ± 1,5
Serin	5,1 ± 1,5
Glutaminsäure	10,9 ± 2,5
Prolin	9,3 ± 1,5
Glycin	11,0 ± 3,0
Alanin	11,7 ± 3,0
Cystein	8,0 ± 4,0
Valin	5,9 ± 1,5
Methionin	1,1 ± 0,5
Isoleucin	2,8 ± 1,5
Leucin	7,5 ± 2,0
Tyrosin	1,6 ± 1,5
Phenylalanin	3,7 ± 1,5
Histidin	2,5 ± 1,0
Lysin	0,8 ± 0,5
Arginin	4,6 ± 1,5

(d) Terminale Aminosäuresequenz:
Aminoterminus:

Ala-Pro-Ala-Glu-Pro-Gln-Pro-Gly-Gly-
Ser-Gln-Cys-Val-Glu-His-Asp-Cys-Phe-Ala-Leu-Tyr-Pro-
Gly-Pro-Ala-Thr-Phe-Leu-

Carboxyterminus: -Leu-Ala-Arg
(e) Stabilität:
(1) Stabil bei pH 2 bis 10
(2) Stabil bei 60 °C für 300 Minuten
(3) Stabil in 1 % (Gewicht/Volumen) SDS,
(4) Stabil in 6 M Guanidinhydrochlorid,
(5) Stabil in 8 M Harnstoff;
(f) Molekulargewicht:
72000 ± 3000;
(g) Zuckerzusammensetzung (% Gewicht/Gewicht)

(1) Neutralzucker:	5,5 ± 1,0
(2) Aminozucker:	2,2 ± 1,0
(3) Sialsäure:	2,8 ± 1,5

(h) Absorption bei 280 nm ($E^{1\%}_{1cm}$):
7,7 ± 1,0 (in wäßriger Lösung);
(i) Isoelektrischer Punkt:
3,9 ± 0,2

2. Verfahren zur Herstellung eines Glycoproteins mit Antikoagulanzaktivität erhältlich aus humanem Urin gemäß Anspruch 1, umfassend die Schritte
(1) Einstellen des pHs des humanen Urins zunächst auf 8,3 ± 0,3 und anschließend entfernen der Präzipitate,
(2) anschließend Einstellung des pHs des Urins auf 7,3 ± 0,2,
(3) anschließend Erhitzen des Urins auf 60 ± 5 °C für 15 ± 5 Minuten;
(4) anschließend Fraktionieren des behandelten Urins durch Affinitätschromatographie unter Verwendung von Thrombin-bindenden Harz, Ionenaustauschchromatographie, Gelfiltration allein oder in

Kombination davon unter Sammlung der aktiven Bestanteile.

3. Pharmazeutische Zusammensetzung zur Prävention oder Behandlung von Krankheiten, die mit Fehlfunktionen im Blutkoagulationssystem einhergehen, die einen pharmazeutisch annehmbaren Träger und ein Glycoprotein mit Antikoagulanzaktivität erhältlich aus humanem Urin gemäß Anspruch 1 umfaßt.

Patentansprüche für folgende Vertragsstaaten : ES, GR

1. Verfahren zur Herstellung eines Glycoproteins mit Antikoagulanzaktivität, erhalten aus humanem Urin, mit den folgenden Eigenschaften:
   (a) Affinität:
   Es hat eine hohe Affinität zu Thrombin;
   (b) Aktivität:
   Es stimuliert die Thrombin-katalysierte Protein-C-Aktivierung;
   (c) Aminsäurezusammensetzung (mol%):

Asparaginsäure	9,5 ± 2,0
Threonin	4,0 ± 1,5
Serin	5,1 ± 1,5
Glutaminsäure	10,9 ± 2,5
Prolin	9,3 ± 1,5
Glycin	11,0 ± 3,0
Alanin	11,7 ± 3,0
Cystein	8,0 ± 4,0
Valin	5,9 ± 1,5
Methionin	1,1 ± 0,5
Isoleucin	2,8 ± 1,5
Leucin	7,5 ± 2,0
Tyrosin	1,6 ± 1,5
Phenylalanin	3,7 ± 1,5
Histidin	2,5 ± 1,0
Lysin	0,8 ± 0,5
Arginin	4,6 ± 1,5

   (d) Terminale Aminosäuresequenz:
   Aminoterminus:

Ala-Pro-Ala-Glu-Pro-Gln-Pro-Gly-Gly-
Ser-Gln-Cys-Val-Glu-His-Asp-Cys-Phe-Ala-Leu-Tyr-Pro-
Gly-Pro-Ala-Thr-Phe-Leu-

   Carboxyterminus: -Leu-Ala-Arg
   (e) Stabilität:
   (1) Stabil bei pH 2 bis 10
   (2) Stabil bei 60 °C für 300 Minuten
   (3) Stabil in 1 % (Gewicht/Volumen) SDS,
   (4) Stabil in 6 M Guanidinhydrochlorid,
   (5) Stabil in 8 M Harnstoff;
   (f) Molekulargewicht:
   72000 ± 3000;
   (g) Zuckerzusammensetzung (% Gewicht/Gewicht)

(1) Neutralzucker:	5,5 ± 1,0
(2) Aminozucker:	2,2 ± 1,0
(3) Sialsäure:	2,8 ± 1,5

(h) Absorption bei 280 nm ($E^{1\%}_{1cm}$):
7,7 ± 1,0 (in wäßriger Lösung);
(i) Isoelektrischer Punkt:
3,9 ± 0,2
umfassend die Schritte
(1) Einstellen des pHs des humanen Urins zunächst auf 8,3 ± 0,3 und anschließend entfernen der Präzipitate,
(2) anschließend Einstellung des pHs des Urins auf 7,3 ± 0,2,
(3) anschließend Erhitzen des Urins auf 60 ± 5 °C für 15 ± 5 Minuten;
(4) anschließend Fraktionieren des behandelten Urins durch Affinitätschromatographie unter Verwendung von Thrombin-bindenden Harz, Ionenaustauschchromatographie, Gelfiltration allein oder in Kombination davon unter Sammlung der aktiven Bestanteile.

2. Verwendung eines Glycoproteins, erhältlich nach einem Verfahren gemäß Anspruch 1 zur Herstellung einer pharmazeutischen Zusammensetzung für die Prävention oder Behandlung von Krankheiten, die mit Fehlfunktionen im Blutkoagulationssystemen einhergehen.

Revendications
Revendications pour les Etats contractants suivants : AT, BE, CH, DE, FR, GB, IT, LI, LU, NL, SE

1. Glycoprotéine purifiée ayant une activité d'anticoagulation pouvant être obtenue a partir de l'urine humaine, qui est caractérisée par les propriétés suivantes :
(a) affinité :
elle présente une forte affinité pour la thrombine;
(b) activité :
elle stimule l'activation de la protéine C catalysée par la thrombine;
(b) composition en amino-acides (moles %) :

Acide aspartique	9,5 ± 2,0
Thréonine	4,0 ± 1,5
Sérine	5,1 ± 1,5
Acide glutamique	10,9 ± 2,5
Proline	9,3 ± 1,5
Glycine	11,0 ± 3,0
Alanine	11,7 ± 3,0
Cystéine	8,0 ± 4,0
Valine	5,9 ± 1,5
Méthionine	1,1 ± 0,5
Isoleucine	2,8 ± 1,5
Leucine	7,5 ± 2,0
Tyrosine	1,6 ± 1,5
Phénylalanine	3,7 ± 1,5
Histidine	2,5 ± 1,0
Lysine	0,8 ± 0,5
Arginine	4,6 ± 1,5;

(d) séquence d'amino-acides terminale
extrémité amino:

Ala-Pro-Ala-Glu-Pro-Gln-Pro-Gly-Gly-Ser-Gln-
Cys-Val-Glu-His-Asp-Cys-Phe-Ala-Leu-Tyr-Pro-
Gly-Pro-Ala-Thr-Phe-Leu-

extrémité carboxy:
-Leu-Ala-Arg;
(e) stabilité :
(1) stable à pH 2 à 10,
(2) stable à 60 °C pendant 300 minutes,
(3) stable dans du SDS à 1 % (P/V),
(4) stable dans le chlorhydrate de guanidine 6M,
(5) stable dans l'urée 8M;
(f) masse moléculaire :
72 000 ± 3 000;
(g) composition en sucres (P/P %) :

(1) sucres neutres	5,5 ± 1,0,
(2) sucres aminés	2,2 ± 1,0,
(3) acide sialique	2,8 ± 1,5;

(h) absorbance à 280 nm

$(E^{1\ \%}_{1\ cm})$:

7,7 ± 1,0 (en solution aqueuse);
(i) point isoélectrique :
pH 3,9 ± 0,2.

2. Procédé de préparation d'une glycoprotéine ayant une activité d'anticoagulation, pouvant être obtenue à partir de l'urine humaine, telle que définie dans la revendication 1
comprenant les étapes consistant à:
(1) ajuster le pH de l'urine humaine d'abord à 8,3 ± 0,3, puis éliminer le précipité,
(2) ajuster ensuite le pH de l'urine à 7,3 ± 0,2,
(3) chauffer ensuite l'urine à 60 ± 5ºC pendant 15 ± 5 minutes,
(4) puis fractionner l'urine traitée par chromatographie d'affinité en utilisant une résine liant la thrombine, chromatographie d'échange d'ions, filtration sur gel seule ou en association avec ces techniques pour recueillir les constituants actifs.

3. Composition pharmaceutique pour la prévention ou le traitement de maladies liées à des perturbations des systèmes de coagulation sanguine, qui comprend un support pharmaceutiquement acceptable et une glycoprotéine ayant une activité d'anticoagulation pouvant être obtenue à partir de l'urine humaine telle que définie dans la revendication 1.

Revendications pour les Etats contractants suivants : ES, GR

1. Procédé de préparation d'une glycoprotéine ayant une activité d'anticoagulation obtenue à partir d'urine humaine ayant les propriétés suivantes :
(a) affinité :
elle présente une forte affinité pour la thrombine;
(b) activité :
elle stimule l'activation de la protéine C catalysée par la thrombine;
(b) composition en amino-acides (moles %) :

Acide aspartique	9,5 ± 2,0
Thréonine	4,0 ± 1,5
Sérine	5,1 ± 1,5
Acide glutamique	10,9 ± 2,5
Proline	9,3 ± 1,5
Glycine	11,0 ± 3,0
Alanine	11,7 ± 3,0
Cystéine	8,0 ± 4,0
Valine	5,9 ± 1,5
Méthionine	1,1 ± 0,5
Isoleucine	2,8 ± 1,5
Leucine	7,5 ± 2,0
Tyrosine	1,6 ± 1,5
Phénylalanine	3,7 ± 1,5
Histidine	2,5 ± 1,0
Lysine	0,8 ± 0,5
Arginine	4,6 ± 1,5;

(d) séquence d'amino-acides terminale
extrémité amino:

Ala-Pro-Ala-Glu-Pro-Gln-Pro-Gly-Gly-Ser-Gln-
Cys-Val-Glu-His-Asp-Cys-Phe-Ala-Leu-Tyr-Pro-
Gly-Pro-Ala-Thr-Phe-Leu-

extrémité carboxy:
-Leu-Ala-Arg;
(e) stabilité :
(1) stable à pH 2 à 10,
(2) stable à 60 °C pendant 300 minutes,
(3) stable dans du SDS à 1 % (P/V),
(4) stable dans le chlorhydrate de guanidine 6M,
(5) stable dans l'urée 8M;
(f) masse moléculaire :
72 000 ± 3 000;
(g) composition en sucres (P/P %) :

(1) sucres neutres	5,5 ± 1,0,
(2) sucres aminés	2,2 ± 1,0,
(3) acide sialique	2,8 ± 1,5;

(h) absorbance à 280 nm

$(E^{1\ \%}_{1\ cm})$:

7,7 ± 1,0 (en solution aqueuse);
(i) point isoélectrique :
pH 3,9 ± 0,2.
comprenant les étapes consistant à :
(1) ajuster le pH de l'urine humaine d'abord à 8,3 ± 0,3, puis éliminer le précipité,
(2) ajuster ensuite le pH de l'urine à 7,3 ± 0,2,

(3) chauffer ensuite l'urine à 60 ± 5 °C pendant 15 ± 5 minutes,
(4) puis fractionner l'urine traitée par chromatographie d'affinité en utilisant une résine liant la thrombine, chromatographie d'échange d'ions, filtration sur gel seule ou en association avec ces techniques pour recueillir les constituants actifs.

2. Utilisation de la glycoprotéine telle qu'elle peut être obtenue par le procédé selon la revendication 1 pour la préparation d'une composition pharmaceutique pour la prévention et/ou le traitement de maladies liées à une perturbation des systèmes de coagulation du sang.

FIG. 1

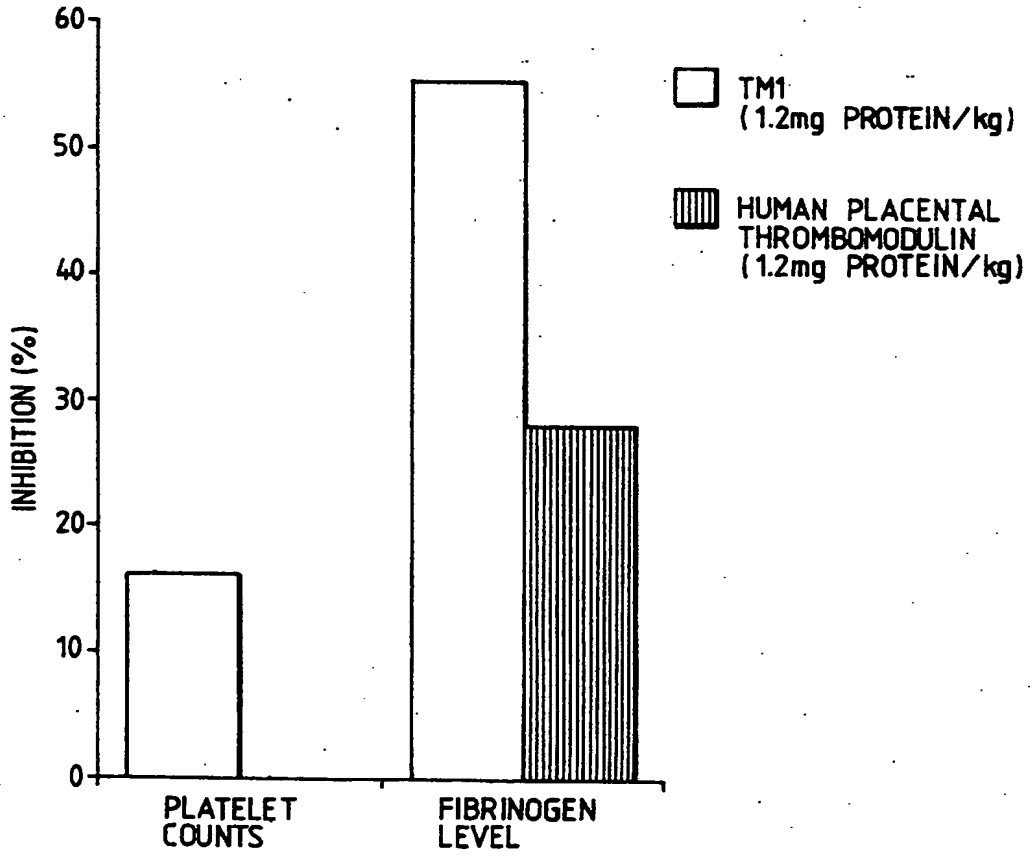

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FIG. 2

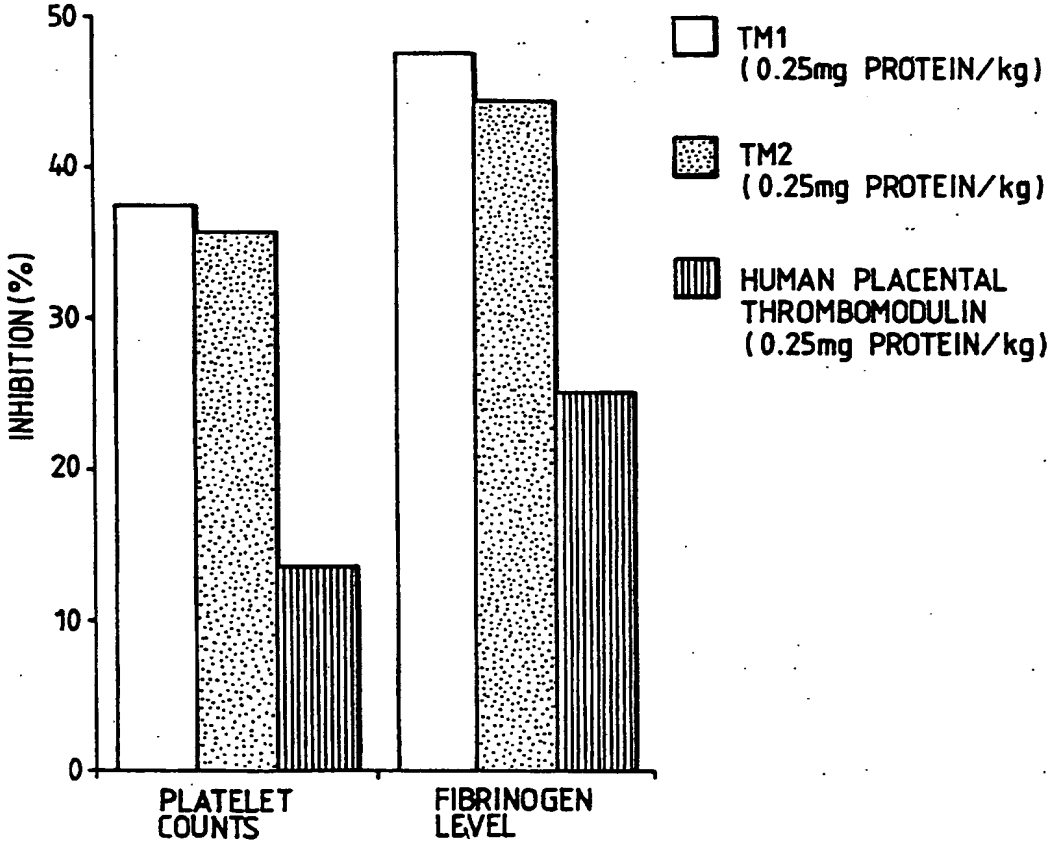

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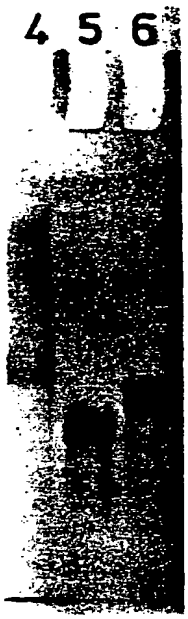
FIG. 3



4 : HUMAN PLACENTAL THROMBOMODULIN
5 : TM1
6 : TM2

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